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9. Springing the Floor for a Different Kind of Dance

Building DARIAH as a Twenty-First-Century Research Infrastructure for the Arts and Humanities

*Jennifer Edmond, Frank Fischer,
Laurent Romary, and Toma Tasovac*

Introduction: What's in a Word?

The word *infrastructure* carries the undeniable whiff of heavy engineering, of tar, and gear oil, all accompanied by the sound of a jackhammer. Looking in a dictionary, we will be reminded that infrastructure is basic and foundational, but also that its primary examples are, and remain (in the imagination, if not in reality) in the realm of bricks and mortar: roads, bridges, electricity grids. But the etymology of the word implies nothing of this sort, merely that somewhere below our line of sight, components that support us have been organised. And so, while they may not have the pleasing tangible durability of steel and tarmac, marketplaces are equally infrastructural, as are networks of individuals and their knowledge.

Research infrastructures (or RIs) present a particular case where this gap between imagination and function can lead to dissonance. According to one definition, RIs are installations and services that

function as ‘mediating interfaces’ or ‘structures “in between” that allow things, people and signs to travel across space by means of more or less standardized paths and protocols for conversion or translation’.¹ A digital research infrastructure is no different: it assembles a mediating set of technologies for research and resource discovery, collaboration, sharing, and dissemination of scientific output.

Infrastructures are not just service providers, however, but also strong cultural and political symbols. From electricity systems in the 1920s, to coal trains in the 1950s, through to the gateways and bridges represented on Euro notes in the present decade, infrastructures have been mobilised repeatedly in broader spheres as symbols and metaphors for the more generalised march of modernisation, integration, and co-operation:² engines of change, propelling society into a better and brighter future. Yet, precisely because those ‘human-built material links between nations and across borders in Europe [...] predated, accompanied and transcended the “official” processes of political and economic integration’,³ it would be all too tempting — and all too easy — to approach the question of digital research infrastructures uncritically by getting caught up in the moment and embracing the master narratives of efficiency and progress without discussing the larger and more complex implications of institutionalising networked research. A digital infrastructure is not only a tool that needs to be built, it is also a tool that needs to be understood.

Every decade or so, the conceptual framework used by digital humanists to situate the work they do into the landscape of research and its infrastructure is redefined. The idea that the digital could provide quick and easy access to resources drove an early ‘access’ paradigm. The fact that we could ask new questions about our data drove the rise of a ‘methods’ paradigm. Now, digital humanities is becoming more mainstream. Furthermore, more of the activities that might be associated

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- 1 Alexander Badenoch and Andreas Fickers, ‘Introduction Europe Materializing? Toward a Transnational History of European Infrastructures’, in *Materializing Europe: Transnational Infrastructures and the Project of Europe*, ed. by Alexander Badenoch and Andreas Fickers (London: Palgrave Macmillan, 2010), pp. 1–23 (p. 2).
 - 2 Badenoch and Fickers, ‘Introduction’, p. 2; see also Stefan Schmunk et al., ‘Interoperabel und partizipativ’, in *Digitale Infrastrukturen für die germanistische Forschung*, ed. by Henning Lobin, Roman Schneider, and Andreas Witt (Berlin: De Gruyter, 2018), pp. 53–72, <https://doi.org/10.1515/9783110538663-004>
 - 3 Badenoch and Fickers, ‘Introduction’, p. 1.

with traditional as well as digital humanities (such as publishing, where word processing would long have been the ‘back end’ norm) are becoming overtly digital, and pressures — such as the move toward open science — are bringing technologies for producing and sharing outputs within the consideration of nearly every productive scholar.

In accordance with this, many voices have emerged in the past five years expressing theories about how infrastructure should be understood and delivered for the arts and humanities. In each case, it seems a different role, place, or perspective is offered on what this organised, optimised substrate might offer or should be, whether that is critical cyberinfrastructure,⁴ conceptual cyberinfrastructure,⁵ tactical infrastructure,⁶ or one of any number of emerging characterisations. The rising interest in digital humanities infrastructure might, therefore, be indicative of the long-expected move toward digital humanities becoming an unnecessary compound phrase, as ‘digital high-energy physics’ would be.

The discussion that follows will take a different approach. This approach entails an examination of practices as much as theories, and an attempt to define infrastructure for the arts and humanities in the digital age — what components it focusses on, what priorities it expresses, how it manifests itself, and how it differentiates itself from its precursors. The discussion will then look specifically at the example of the relatively centralised landscape of research infrastructure in Europe, and the iterative development of the DARIAH ERIC, a consortium of countries committed to a shared programme deployed on behalf of arts and humanities researchers in Europe to build research infrastructure. In particular, the latter half of this chapter will delve into the unique structures and functions this new model of research infrastructure has taken on, taking lessons from the digital humanities, but serving always the disciplines underlying them.

4 Alan Liu, ‘Toward Critical Infrastructure Studies’, Paper Presented at the University of Connecticut, Storrs, 23 February 2017, <http://cistudies.org/wp-content/uploads/Toward-Critical-Infrastructure-Studies.pdf>

5 Patrik Svensson, ‘From Optical Fiber To Conceptual Cyberinfrastructure’, *Digital Humanities Quarterly*, 5.1 (2011), <http://www.digitalhumanities.org/dhq/vol/5/1/000090/000090.html>

6 UC Digital Humanities, ‘Dr. Tim Sherratt: Towards a Manifesto for Tactical DH Research Infrastructure’, *Youtube*, 2 November 2015, <https://www.youtube.com/watch?v=FL5pP2ysjU4>

But What Is Research Infrastructure?

Trying to extract a succinct definition for *research infrastructure* from existing literature quickly leads to the sense one is listening to the proverbial blind men describing an elephant, each with a different impression of what its purpose might be. In part, this is a result of the many different communities from which these definitions emerge. In order to try and distil a common, consolidated definition, we might start from a set of six published takes on the essence of research infrastructure. Critically, these are derived from six different perspectives: library science, information science, US and EU policy statements, implementation, and cultural theory.⁷

Among these definitions there is very little consensus about what a research infrastructure is comprised of and what its priorities should be. What we can extract from them, however, is a list of components they may have, attributes that may define them, and things they may do. In short, research infrastructures may have the following: facilities, resources, human resources, services, equipment, instruments, collections, archives, databases, structured information systems, grid, computing, software, middleware, information, expertise, standards, policies, tools, knowledge, data, people, a wide user base, and standardised paths and protocols.

At the risk of adding yet another set of elements to the list, we would suggest that this quite varied list can be boiled down to six encompassing categories of assets: tacit and explicit knowledge; networks and communities; software and services; research data collections; labs and instruments; and, finally, buildings and facilities. In and of themselves, none of these assets are inherently infrastructural. However, they can achieve this status by the manner in which they are made available, interoperable, and sustainable. Without these aspects in place, such elements may exist, but within a silo that cannot be shared and reused at a level beyond the walled garden of a project with a limited user group or time limit: a status that renders them unable to meet the minimal requirements of infrastructure.

Returning to our set of definitions, we learn that research infrastructures may be: single-sited, distributed, or virtual;

⁷ For full definitions and citations of the sources used, see Appendix 9.A.

technology-based; shared, unbounded, heterogeneous, open, and evolving; complex agglomerations; diverse; unique; shared broadly; for specific scholarly purposes; sociotechnical systems; an installed base of diverse information technology capabilities; user, operations, and design communities; and more specific than a network, but more general than a tool.

What this multiplicity implies is that research infrastructures are not simply one thing, but exist along a continuum of specialisation, with some able to provide generic support to a wide range of scholars, and others more specialised and serving a smaller group. A possible taxonomy of these levels and types of intervention, offering different assets at different intensities to their user groups, would include technical backbone infrastructures, like GÉANT or national high-speed communications networks for research; standards organisations like the W3C (World Wide Web Consortium), but also the more specific TEI (Text Encoding Initiative) consortium; research centres, which may cover a range of disciplines at a single institution; and, of course, knowledge or memory infrastructures, like museums, libraries, and archives. None of these examples are discipline-specific,⁸ however, and one can also observe a model of infrastructure for one or more disciplines that provides bespoke access to a number of assets, and fuses together aspects of these models. There are two other key attributes, however, that any research infrastructures are likely to share: scale and complexity. Without this, a development may be characterised as a tool, useful for a small cohort but unable to intervene widely or in a way that supports community norms without requiring them to adapt significantly to an infrastructurally-enhanced environment.

With a final nod to the existing set of definitions, research infrastructures may undertake to mediate; may allow things, people, and signs to travel across space; may allow individuals to achieve beyond their capacity to know, to do, to see; may support research; and may get ‘below the level of the work’, a phrase that merits particular attention. The fact that research infrastructures serve research, may seem too obvious to highlight, but many platforms and resources that are hugely useful for the general public or as a teaching resource simply do not have the rigour or richness to support research, and it is difficult

8 Except, maybe, for the TEI, whose target audience is essentially humanities scholars.

to retrofit this if it has not built in from the start. The point of inflection, where an infrastructure meets these research needs, is also important, however. It is for this reason that the idea that research infrastructure 'gets below the level of the work' is still worth pausing over almost twenty years after it was first proposed. According to the authors of *Understanding Infrastructure: Dynamics, Tensions and Design*, the ideal state for infrastructure is to be:

[operating] without specifying exactly how work is to be done or exactly how information is to be processed (Forster and King, 1995). Most systems that attempt to force conformity to a particular conception of a work process (e.g., Lotus Notes) have failed to achieve infrastructural status because they violate this principle (Grudin, 1989; Vandenbosch and Ginzberg, 1996). By contrast, email has become fully infrastructural because it can be used for virtually any work task.⁹

This perspective is not only very much in line with the etymology of the word in question, as discussed in the introduction to this chapter, it also continues to express a key element of how any infrastructure must operate, and the relationship it must have to its users. It also acts as a counterweight to the physicality of the stereotypical images of infrastructures, so common in the imagination and so antithetical to the arts and humanities. As such, it facilitates thought experiments that might define how these two worlds could merge via bridging concepts able to bring to the fore the centrality of knowledge exchange and human interaction in these disciplines. One particular rich field of terminology in this context is that of 'knowledge spaces' or 'knowledgescapes'.

Infrastructures as Knowledge Spaces

According to a pan-European interdisciplinary network of researchers focussed on the potential of the knowledge space as a powerful alternative for knowledge organisation and sharing:

From libraries to the web; [...] From science maps to interactive knowledge maps; [...] From fundamental research to infrastructures: Physicists, working on complex networks, have developed alternative approaches to knowledge organization by extracting patterns from

⁹ Paul N. Edwards et al., *Understanding Infrastructure: Dynamics, Tensions and Design* (Ann Arbor, MI: Deep Blue, 2007), p. 17, <http://hdl.handle.net/2027.42/49353>

emerging networks of digitized information. But connections to traditional knowledge orders are rarely discussed, which also hampers their diffusion into information retrieval.¹⁰

The idea that an infrastructure could facilitate not just the transfer of physical objects or data, but also of knowledge and ideas, is not new. Nonetheless, the idea of the knowledge space opens up a number of intriguing, related semantic spaces. First of all, knowledge spaces are related to the development of ‘collective intelligence’, a capacity that is ‘a much stronger predictor of the team’s performance than the ability of individual members’,¹¹ which draws on and increases the ‘ability to coordinate tacitly and dynamically’¹² and support ‘cognitive or meta-cognitive processes’.¹³

Building infrastructures based upon the fostering of knowledge spaces also gives access to the creation of a ‘transactive memory system’ (TMS), which can be defined as a ‘shared system that individuals in groups develop to collectively encode, share and retrieve information or knowledge in different domains [... for which] there are three behavioural indicators [...]: specialization, credibility and coordination’.¹⁴ This model is therefore highly relevant, as one of the key attributes of infrastructure (as will be discussed in the next section) is scale; and scale requires a division of labour (specialisation), trust between collaborators originating from different epistemic cultures (credibility), and a whole that becomes greater than the sum of its parts (coordination). These capacities of the transactional memory system would enable an infrastructure based on knowledge, even when applied to such a diverse set of disciplines and approaches as the arts and

10 Knowescape Project, *Memorandum of Understanding for the Implementation of a European Concerted Research Action Designated as COST Action TD1210: Analyzing the Dynamics of Information and Knowledge Landscapes — KNOWeSCAPE* (Brussels: COST European Cooperation in the Field of Scientific and Technical Research, 2012), p. 5, <http://knowescape.org/wp-content/uploads/2013/04/TD1210-e.pdf>

11 Anita Williams Woolley, Ishani Aggarwal, and Thomas W. Malone, ‘Collective Intelligence in Teams and Organisations’, in *Handbook of Collective Intelligence*, ed. by Thomas W. Malone and Michael Bernstein (Cambridge, MA: MIT Press, 2015), pp. 143–57 (p. 143), citing Anita Williams Woolley et al., ‘Evidence for a Collective Intelligence Factor in the Performance of Human Groups’, *Science*, 330 (2010), 686–88.

12 Williams Woolley, Aggarwal, and Malone, ‘Collective Intelligence’, p. 147.

13 Ibid., p. 150.

14 Ibid., p. 150.

humanities, to truly facilitate knowledge exchange and the extension of methodologies and fields from ‘below the level of the work’, as well as to build a peer production-style system of incentives to collaborate, such as the ‘intrinsic enjoyment of doing the task, benefits for the contributors from using the software or other innovations themselves, and “social” motivations fed by the presence of other participants on the platform’.¹⁵

Why Do the Arts and Humanities Need Research Infrastructure?

The technical and material biases that endure in the discourse about research infrastructure also create biases in the general perception of what disciplines require it. However, ‘it was in the field of Humanities that the idea of an RI was first born’,¹⁶ in the form of the famed Library of Alexandria and its less well-known precursors, of which there is evidence going back thousands of years before the birth of Christ. Even in their digital/social manifestations, the arts and humanities established themselves far earlier than many may believe, with the founding of the TEI Consortium having occurred already in 1987. But the researcher’s requirements in the twenty-first century, even in the arts and humanities, are no longer covered completely by the library or archive, even a digital one, and reach far beyond the ambit of a single textual standard (though the TEI is still a major force). Knowledge infrastructures are distinct, and their digital manifestations bring some of their traditional strengths (and weaknesses) to the next generation of their development.

As one of the authors of this chapter has described in more detail elsewhere,¹⁷ the growing accessibility of digital sources has exposed a gap between the infrastructure and its users, which has perhaps always existed, but which is made all the more apparent now because of growing virtual access paradigms and the rise of transnational

15 Ibid., p. 157.

16 Claudine Moulin et al., *Research Infrastructures in the Digital Humanities* (Strasbourg: European Science Foundation, 2011), p. 3, http://www.esf.org/fileadmin/user_upload/esf/RI_DigitalHumanities_B42_2011.pdf

17 Jennifer Edmond, ‘Tradition and Innovation in the Cendari Research Infrastructure’, *Review of the National Center for Digitization 25*, ed. by Zoran Ognjanović (Belgrade: Faculty of Mathematics, University of Belgrade, 2015), pp. 2–9.

approaches to humanities research. The gradual bifurcation between the ‘keepers of the sources’ and ‘facilitators of the activity’ was not so much of a problem when access to sources was predicated on occupying the ‘space’ of a particular holder of rights and knowledge about source material, by which one might mean a library, archive, museum, or indeed a publisher. Cultural heritage institutions are being challenged in their capacity to maintain what is produced by scholars, as production moves from shelves to racks; in their capacity to enable new methodologies in the move beyond reading to ‘distant reading’; in their capacity to maintain the high ‘up-front’ investment required for traditional cataloguing and metadata production; and in their capacity to federate meaningfully across thematic and institutional boundaries.

In short, the challenge of the digital library is to balance old values with the new. In this struggle, we do not want — nor can we afford — to see libraries, museums, and archives forgo their traditional roles as the keepers and protectors of cultural memory. And yet, as the nature of scholarship itself is changing, in the arts and humanities as much as anywhere else, due to the rapid and transformative influence of technology, new, potentially incompatible, requirements for research infrastructure are also emerging. No matter what discipline you work in or how you work, all humanists today must engage with the digital in their work processes, whether their approach engages humanities ‘at scale’ or in the ‘long tail’.

The opportunities are immense, but there are risks as well: ‘Faced with the digital “black box”, digital models can be imposed upon researchers whose needs in terms of information processing are too often not explained concretely’.¹⁸ The entire field of digital humanities is evolving against the backdrop of global capitalism in its electronic mode, the so-called ‘eEmpire’, which is sustained by ‘a loose assemblage of relations characterized by [...] flexibility, functionality, mobility, programmability, and automation’.¹⁹ It would be naive to think that our fields are immune to the economic and ideological tensions that

18 Samuel Szoniecky, ‘Ecosystems of Collective Intelligence in the Service of Digital Archives’, in *Collective Intelligence and Digital Archives: Toward Knowledge Ecosystems*, ed. by Samuel Szoniecky and Nasreddine Bouhaï (Hoboken, NJ: Wiley, 2017), pp. 1–22 (p. 10), <https://doi.org/10.1002/9781119384694.ch1>

19 Rita Raley, ‘eEmpires’, *Cultural Critique*, 57 (2004), 111–50, <https://doi.org/10.1353/cul.2004.0014>.

characterise information capitalism. It would be even more naive to think we can build expensive, transnational digital research infrastructures that will function in some abstract networked space unburdened by politics and ideology.

Care must be taken, and a community approach adopted. This approach must take into account both the superuser and the marginal case, and must underpin developments as research infrastructure for the arts and humanities seeks to meet the baseline requirements outlined above: scale, openness, durability, and fitness to a broad purpose. It is also important to remember that, in another departure from the old models of the bricks and mortar infrastructure, digital research infrastructure will be a moving target, never able to be viewed as completed or finished. Technology, and its adoption, moves too fast for this to be otherwise. At its best, however, infrastructure will allow any discipline — including, and perhaps particularly, the diverse and atomised arts and humanities — to gain access to networks, data, and knowledge; to achieve greater efficiency and insight in work; to enhance pathways for visibility, reuse and impact; to bring better alignment with shared standards and policy frameworks (such as open science); to increase opportunities for seeking collaborative funding; and to promote long-term sustainability of research outputs.

History of a New Model of RI Development

The rise of a research infrastructure model that could fulfil this significant set of requirements has of course been iterative, but in particular the year 2006 can be pinpointed as being the moment of its consolidation. In this year, two significant publications, one in the US and one in Europe, pointed toward the path along which research infrastructure now develops.

The first of these two publications was the American Council of Learned Societies (ACLS) report on what it called ‘humanities cyberinfrastructure’, entitled *Our Cultural Commonwealth*, and chaired by John Unsworth.²⁰ The report was itself a response to an earlier

20 American Council of Learned Societies, *Our Cultural Commonwealth: The Report of the American Council of Learned Societies Commission on Cyberinfrastructure for the Humanities and Social Sciences* (New York: American Council of Learned Societies,

one on cyberinfrastructure for science and engineering in the United States, a document generally known as the Atkin's report.²¹ While the characteristics of a cyberinfrastructure system for cultural data and investigation described in the ACLS report may have slightly different characteristics from those described elsewhere in this chapter, the eight recommendations given are still remarkably relevant more than a decade later:

1. Invest in cyberinfrastructure for humanities and social science, as a matter of strategic priority.
2. Develop public and institutional policies that foster openness and access.
3. Promote cooperation between public and private sectors.
4. Cultivate leadership in support of cyberinfrastructure from within the humanities and social sciences.
5. Encourage digital scholarship.
6. Establish national centres to support scholarship that contributes to and exploits cyberinfrastructure.
7. Develop and maintain open standards and robust tools.
8. Create extensive and reusable digital collections.²²

At the same time as Unsworth and his collaborators were developing these recommendations, similar thinking was going on in Europe, albeit not always reaching the same conclusions. In fact, the most prominent representative of what could be seen as a coordinated and comprehensive approach to fulfilling these requirements, namely the Arts and Humanities Data Service (AHDS) in the UK, was defunded in March of 2007. After a decade of supporting the digital aspects of research across the humanities disciplines through its central services

2006), https://www.acls.org/uploadedFiles/Publications/Programs/Our_Cultural_Commonwealth.pdf

21 Daniel E. Atkins et al., *Revolutionizing Science and Engineering Through Cyberinfrastructure: Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure* (Washington, DC: National Science Foundation, 2003), <https://www.nsf.gov/cise/sci/reports/atkins.pdf>

22 American Council of Learned Societies, *Our Cultural Commonwealth* (table of contents).

and distributed subject centres, the move left researchers in the UK concerned about the future of support for their work.

While the view from the UK may have seemed opposed to Unsworth and his collaborators' vision, at the European policy level, the future seemed much brighter. A second document published in 2006 was the European Strategic Forum for Research Infrastructure (ESFRI) roadmap,²³ which outlined an initial set of priority investments for pan-European research infrastructures that (it was proposed) member states would build and maintain in a coordinated fashion. On this initial roadmap were three entries with a strong humanities focus: CLARIN,²⁴ the Common Languages Resources and Technology Infrastructure; EROHS, the European Research Observatory for the Humanities; and DARIAH,²⁵ the Digital Research Infrastructure for Arts and Humanities.

Of these three, only two ever reached the launch stage: EROHS, like the AHDS, but also like the US-based, Mellon Foundation-funded Project Bamboo, is not currently operational, nor did it ever become so. Of the two remaining humanities research infrastructures on that original roadmap, DARIAH's role and impact is perhaps the more challenging one to understand. CLARIN takes a well-defined community (linguists) and offers them a relatively clear set of tools and services. However, DARIAH serves a more inchoate and diverse community — the arts and humanities writ large — and provides them with something other than a digital library or archive. This task has demanded a different kind of approach, which will be explored below. Nonetheless, DARIAH has been, by every available measure, a successful intervention: after a number of years of preparatory work, it was established as a European Research Infrastructure Consortium (or ERIC) in 2014, and funded from that point on by contributions from the participating member states. In 2016 it was named an ESFRI 'Landmark' project, and its so-called 'operational phase' began in 2019.

Part of DARIAH's success seems to stem from precisely the ways in which it has distinguished itself, even at a structural level, from the other infrastructures on that first ESFRI roadmap. These aspects

23 European Strategy Forum for Research Infrastructures, *European Roadmap for Research Infrastructures Report 2006* (Luxembourg: Office for Official Publications of the European Communities, 2006) https://ec.europa.eu/research/infrastructures/pdf/esfri/esfri_roadmap/roadmap_2006/esfri_roadmap_2006_en.pdf

24 CLARIN ERIC, <https://www.clarin.eu/>

25 DARIAH-EU, <https://www.dariah.eu/>

highlight how DARIAH has deployed itself as an infrastructure, but also as a knowledge space for its community. This can be seen, in part, through its relative size at launch: of the first six ERICs launched in 2011–2013, two thirds launched with less than ten national members signed on, a third with only half of that. DARIAH launched with a full fifteen members, and two more joined very shortly after the ERIC had been formed. But critical mass was not the only differentiator. Of those six first infrastructures based on the new European consortial model, only two deployed any sort of in-kind contribution in their funding model, and in those cases the support was specifically earmarked to run national modules or nodes (as in the European Social Survey). In DARIAH, however, the in-kind contributions actually make up a far greater proportion of the member funding requirement than the cash. To be a DARIAH member, countries must organise themselves and their research bases in order to share the tools, data, and knowledge that are developed locally, prioritising reuse and integration over the development of centralised shared services from scratch.

This quirk in the DARIAH funding model reflects the nature of the arts and humanities community and their research, but also the manner in which DARIAH has constructed itself, not merely as, what organisational theorists and economists call a hierarchy, but also as a marketplace.²⁶ This is a key differentiator given that '[o]ne of the most important ways in which members of groups and organizations coordinate is through their structure. Moreover, the larger the group the more important structure can be in determining the group's effectiveness'.²⁷ In general, theorists tend to dismiss the marketplace as appropriate to this structuring task, but there are places where it is highly effective: 'If assets are nonspecific, markets enjoy advantages in both production cost and governance cost respects [...] markets can also aggregate uncorrelated demands, thereby realizing risk-pooling benefits; and external procurement avoids many of the hazards to which internal procurement is subject.'²⁸ If anything can be characterised as a nonspecific asset that meets uncorrelated demands, it is humanities and arts research; and for this, this marketplace model is highly effective. It

26 Oliver E. Williamson, 'The Economics of Organization: The Transaction Cost Approach', *American Journal of Sociology*, 87.3 (1981), 548–77.

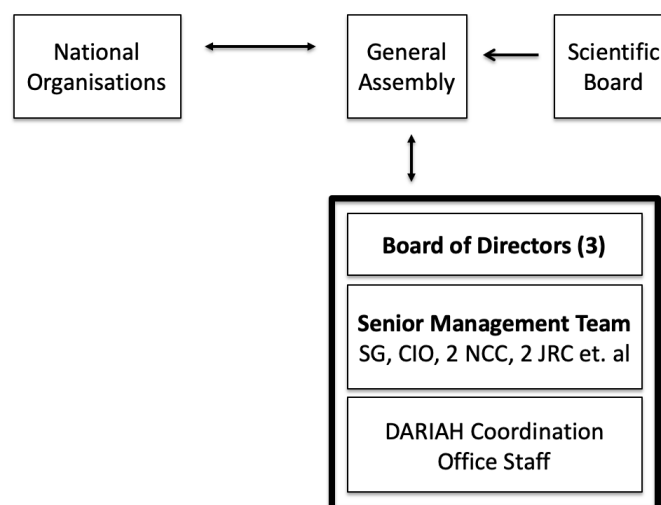
27 Williams Woolley, Aggarwal, and Malone, 'Collective Intelligence', p. 147.

28 Williamson, 'Economics of Organization', 561.

is also effective when demand is not bilateral, another key aspect of the DARIAH environment.

However, the marketplace aspect of the DARIAH structure is not just a reflection of the privileged place of the in-kind contribution in its funding model. Its entire organisational structure, which is also very different from any other ERIC, reflects this mentality. This is not to say that DARIAH has no hierarchical structure; in fact, it has a very traditional chain of command, with an executive team reporting to a board of directors, who, in turn, answer to a general assembly comprised of representatives of its funders, who each also oversee a national coordinating institution and team. Operating alongside this hierarchy, and feeding into it, however, is a second structure optimised for knowledge sharing and in-flow into the organisation. In this marketplace, a set of four 'Virtual Competency Centres' (VCC) act as gateways and quality assurance nodes for the contributions, not just of the national in-kind contributions (though these have a special status within the information flows), but also from associated research projects and transnational working groups established under the DARIAH umbrella, which will be described in more detail below. The complementarity and links between these two structures can be seen in Figure 1.

DARIAH ERIC as Hierarchy



DARIAH ERIC as Marketplace

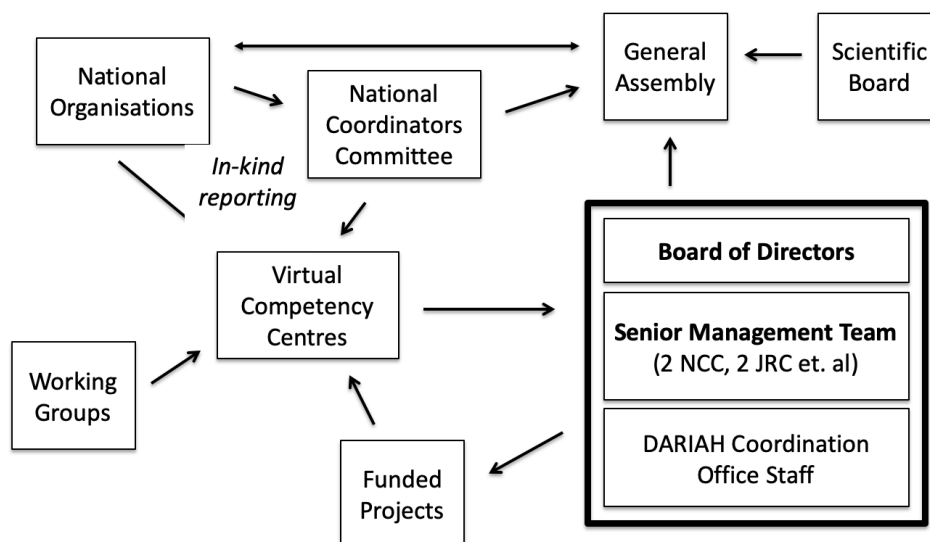


Fig. 1 DARIAH as Hierarchy and DARIAH as Marketplace. [Figure prepared by the author].

In this way, DARIAH is able to structure its activities so as to meet a quite different and ever-changing set of needs from within its community.

The Activities of the DARIAH ERIC

As outlined above, the DARIAH ERIC serves a broad community, building a new kind of research infrastructure and even sitting between ministries within the European Commission's structure by bringing together elements of the digital agenda, cultural heritage, and education into a research-focussed mission. The need to approach these challenges in a distinct way has been outlined above. However, DARIAH is more than an empty structure. Indeed, the top priority for the national partners, and indeed the researcher-stakeholders, is the impact of DARIAH and the services it delivers.

This is not to say that DARIAH cannot be of benefit merely through the nature of its existence as a body that can speak — if only through the ultimately limited lens of technology — for the needs of the arts and humanities as a whole. Having a mechanism with which to unite the needs of these communities is of benefit in and of itself, creating broadly shared vision and goals within a large community, bringing flexibility

and empowerment to local nodes (creating a collective of independent decision makers), harnessing ‘collective intelligence’, and contributing to the creation of the transactive memory system described above.

DARIAH cannot provide sufficient value to justify the investments made in it merely by existing, and the user-determined worth of infrastructure can make the defining of a clear value proposition difficult in a broad community. For this reason, DARIAH focuses on delivering four flagship initiatives and frames for its activity, allowing it to combine the advantages of top-down and bottom-up development for both the most naive and the most experienced of its users.

These four areas are as follows: a marketplace for validated tools, services, and data aimed at providing inspiration and solutions for the digital aspects of day-to-day research; transnational working groups at the cutting edge of disciplinary and community development; policy and foresight work; and the development of training and career pathways. With these areas, DARIAH seeks to intervene in its environment through a set of ‘meta-ideas’, which are defined by Paul Romer as:

[...] ideas about how to support the production and transmission of other ideas. In the seventeenth century, the British invented the modern concept of a patent that protects an invention. North Americans invented the modern research university and the agricultural extension service in the nineteenth century, and peer-reviewed competitive grants for basic research in the twentieth. The challenge now facing all of the industrialized countries is to invent new institutions that encourage a higher level of applied, commercially relevant research and development in the private sector.²⁹

Each of these key areas, and the manner in which they can be delivered as an infrastructural service, will be described below.

The DARIAH Marketplace

Of the four key areas on which DARIAH focusses, the most visible is the DARIAH Marketplace for tools, services, data, and knowledge. Structuring DARIAH to function as a marketplace has been an iterative development over the course of the first ten years of the organisation’s

29 Paul Romer, ‘Economic Growth’, *Library of Economics and Liberty*, <http://www.econlib.org/library/Enc/EconomicGrowth.html>

development. What is now called the ‘SSH Open Marketplace’ will become the showpiece of that set of guiding principles. It addresses a longstanding expression of requirement within the research community that has proven challenging to meet, for an optimal and rich environment for humanists and others to share tools, services, and data. DARIAH’s advantage in attempting to meet this need stems from its ability to embed its response in a community framework, harnessing DARIAH’s unique in-kind contribution assets, a robust quality control mechanism through its Joint Research Committee and Virtual Competency Centres, reuse cases and contextual material, as well as a reuse imperative, driven by the European policy impulses behind Open Science and in particular the development of the European Open Science Cloud (EOSC).

The development of the EOSC and the manner in which the DARIAH Marketplace frames a bespoke response to it for the arts and humanities provides a good case study for how DARIAH serves its community. The EOSC is being developed as an engine to facilitate the ‘most exciting and ground-breaking innovations [that] are happening at the intersection of disciplines’.³⁰ The vision behind such a grand statement is that by enabling (and encouraging, with the carrot and stick approach) researchers to share not just their completed results in the form of publications, but their research data as well, European researchers will be able to move more fluidly between questions and disciplines, increasing their impact both scientifically and socially. In theory, the EOSC will encompass all disciplines. However, humanists are not always able to share their data, as it may be ‘owned’ by either an author/creator, or, indeed, a publisher or cultural heritage institution with responsibilities to preserve it, protect it and manage access and use. In addition, humanists do not use data in the same way as other disciplines, and indeed may not even recognise their sources as data. The EOSC will eventually see all researchers who receive European funding required to deposit their research data for reuse, a fact that is of particular concern and interest to DARIAH, as the mismatch between current conceptualisations of data sharing and reuse, including the widely accepted FAIR principles, are largely out of step with existing

30 Carlos Moedas, ‘The European Open Science Cloud — The New Republic of Letters’, *European Commission* (12 June 2017), https://ec.europa.eu/commission/commissioners/2014-2019/moedas/announcements/eosc-summit-european-open-science-cloud-new-republic-letters_en

humanistic research practices. By building the DARIAH Marketplace as a community-tuned response to EOSC, DARIAH will be able to lead the way, but also mediate between communities of practice currently not in dialogue.

The prospective that the DARIAH Marketplace will be able to manage the risks of epistemic mismatch in a convergent European science system is a strong incentive, but by no means the only one. As DARIAH director Frank Fischer described the vision of the development in a 2017 keynote address,

Right now, there is no place I could recommend to fellow researchers, where they could go, to look for digital tools or services developed and carved out for the Humanities. Well of course, Google will help you. If you know what you want, that is. But having a central place with tools and services for the Humanities, which is community-driven, where you can find solutions, would be a benefit, and surveys have shown that there's a strong demand for it within the field. A place where you can also count on serendipities, where you can find things you weren't even looking for.

And this is when the DARIAH Marketplace comes into play.

The DARIAH Marketplace is planned as a central, easy-entry place where humanists can find support for the digital aspects of their research. Think of it like a library, but with digital solutions instead of physical books. It will address all humanists, not just those who would regard themselves as digital humanists. It will contain a collection of software, tools, services, datasets, publication repositories and learning & training material and will establish visibility for them.³¹

Through this significant development, DARIAH will deliver on the surprisingly difficult, but long-desired, need for community-based, collective progress in the digital humanities. Delivering fully on this vision will be a worthwhile, albeit decades-long, project: it will significantly contribute to the accessibility of digital approaches in the humanities; it will create visibility, and promote reuse and sustainability for the national contributions DARIAH receives; and it will increase awareness of the barriers to the potential reuse value of digital resources built by researchers for researchers, as well as how to redress these barriers.

31 Frank Fischer, 'Towards the DARIAH Marketplace. An Appstore for the Humanities', Keynote Address at DARIAH Innovation Forum, Aarhus, Denmark, November 2–4, 2017.

DARIAH Working Groups

Although DARIAH has always had working groups focussed on particular key task areas, the idea to open up these groups to development from outside the VCC structure only came when the ERIC structure for the membership organisation was launched in 2014. Moving from a top-down to a bottom-up structure has proven highly relevant to community needs however, and the demand for forming these largely unfunded, loose organisations of researchers quickly pushed the number from a handful to over two dozen. Their focus areas are as diverse as they are compelling, from Impactometrix to Federated Identity, and from Women Writers to Natural Language Processing (NLP) approaches.

The working groups provide benefit for both the infrastructure and the participants. They ensure that DARIAH is aware of, as well as meeting, the emergent needs of research communities in the humanities, and, in turn, gives the infrastructure a platform for engagement with them. For the researchers, it provides a non-competitive, non-time-limited, lightweight, transnational mechanism for organising themselves. In addition, there is some funding available to them, and opportunities to meet and showcase their activities are a part of the annual DARIAH meetings, which also encourage exchange and sharing among the groups. More than anything else, however, they facilitate input from the most granular level of the DARIAH stakeholder community: individual researchers and research projects with needs beyond the technical or knowledge landscape they have access to locally.

Policy and Foresight

The average researcher does not care about the process of policy-making, nor should they necessarily have to, as it is a specialist area with its own language, rules, and terms of engagement. That said, the future working conditions researchers will encounter will be determined, at least in part, by policy decisions, and the digital is a particularly pronounced place for research policy to be focussed. For this reason, raising a voice in policy discussions is a key service that DARIAH can provide.

Speaking with a single voice has long been a challenge for the arts and humanities; with so many approaches and disciplines grouped under

one term, and not organised in any systematic way, but with a tradition of critical rather than consensual engagement, one can see how hard it would be to forge one. Nonetheless, the concerns of infrastructure provide common ground that makes it easier for the community to agree, or at least to be able to find a common direction to work toward on a number of issues.

The EOSC was mentioned above, and the open science agenda that has given rise to this institution is also a good backdrop against which to consider the kinds of policy engagements DARIAH takes on for the benefit of the arts and humanities research community. A certain amount of this takes the form of actively seeking out and maintaining membership in relevant bodies and projects, such as the Commission's stakeholder body, the Open Science Policy Platform (OSPP);³² open publishing initiatives such as HIRMEOS,³³ OPERAS,³⁴ and OpenAIRE;³⁵ training initiatives like FOSTER+³⁶ and the OS MOOC;³⁷ and EOSC-facing initiatives like the EOSC-hub,³⁸ EOSC Governance Development Forum (EGDF),³⁹ and the SSH EOSC Cluster, SSHOC.⁴⁰ In each of these, DARIAH represents the humanities' perspective, which could be otherwise entirely lost or overlooked, ensuring that the highest-level environment is as friendly as possible to the research communities DARIAH serves, and that those communities are in turn as aware as possible of the trends that will shape their research in the future.

Training, Education, Skills, and Careers

Infrastructures today represent a different model for supporting knowledge creation, but are also, almost as a side effect, developing new models for creating knowledge, differently to their equivalents

32 'Open Science Policy Platform', *European Commission*, <https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-policy-platform>

33 *High Integration of Research Monographs in the European Open Science Infrastructure (HIRMEOS)*, <http://www.hirmeos.eu>

34 *Open Scholarly Communication in the European Research Area for Social Sciences and Humanities (OPERAS)*, <https://operas.hypotheses.org/>

35 *OpenAIRE+*, <https://www.openaire.eu/>

36 *Foster+*, <https://www.fosteropenscience.eu/>

37 *Open Science MOOC*, <https://opensciencemooc.eu/>

38 *EOSC-hub*, <https://eosc-hub.eu/>

39 *EOSCpilot*, <https://eoscipilot.eu/>

40 *SSHOC*, <https://sshopencloud.eu/>

in universities and research institutes. They promote different kinds of learning and career development opportunities, often through acculturation processes,⁴¹ but also through certain kinds of overt skills training and formal programmes of access to infrastructures like DARIAH. They are also often a place where careers grow along pathways similar to what has been proposed in the North American conceptualisation of the ‘alternate academy’.⁴²

Skills acquisition through an infrastructure cannot lend the same formal recognition to participants that one of the many digital humanities doctoral or master’s programmes can, but they can serve what may be a more targeted expression of requirement. As Antonijević has described from the results of her ethnography of digital humanists, humanists prefer and learn best in practical settings, when training is embedded in their area of study, and when it develops naturally and interactively.⁴³

Into the future, DARIAH expects to see the role of infrastructures continue to rise in importance as a locus for building skills and supporting the new career paths for the research-trained who continue to emerge. Indeed, hierarchies for knowledge creation are in the process of shifting generally (e.g. through the popularisation of ‘citizen science’), and applied forms of ‘problem-’ or ‘mission-based’ research are on the rise: modes of work that are perhaps uniquely well-supported in and through the new organisational structure for the arts and humanities that infrastructures like DARIAH provide.

Conclusions (and a Few Concerns)

It is undeniable that technology is delivering a sea-change in many aspects of our lives, and arts and humanities research is not immune to this. As a facilitator for this change, the DARIAH research infrastructure

41 Geoffrey Rockwell and Stéfán Sinclair, ‘Acculturation and the Digital Humanities Community’, in *Digital Humanities Pedagogy: Practices, Principles and Politics*, ed. by Brett D. Hirsch (Cambridge: Open Book Publishers, 2012), pp. 177–211, <https://doi.org/10.11647/obp.0024.08>

42 *#Alt-Academy 01: Alternative Academic Careers for Humanities Scholars*, ed. by Bethany Nowviskie (New York: MediaCommons Press, 2014), <http://mediacommons.org/alt-ac/>

43 Smiljana Antonijević, *Amongst Digital Humanists: An Ethnographic Study of Digital Knowledge Production* (London, New York: Palgrave Macmillan).

has constituted itself so as to preserve the traditions of the arts and humanities while also encouraging and supporting the uptake of new tools, methods, and opportunities, as well as occupying a unique place in the research landscape. This mission is summarised through the following four points:

- DARIAH serves the arts and humanities research community as an infrastructure, providing a common baseline of access to knowledge and services, but also as an ‘interstructure’ connecting potentially isolated researchers and fields and creating a fluid basis for the exchange of new insights and methods between them.
- DARIAH complements its stakeholder community, creating a responsive but also protective membrane between the fast-changing world of digital tools and scientific opportunity on the one hand, and the specificity of approaches and contexts that is central to the work of individual humanistic researcher on the other.
- DARIAH’s role is far more practical than theoretical. It is comprised of the creators who serve explorers: encouraging and activating, building bridges, drawing up processes, and designing tools that make humanities research more fulfilling and less isolating.
- DARIAH is driven by a passion for the humanities, for their potential to flourish in the digital age, and to serve social, cultural, and economic needs.

The development of the DARIAH ERIC is a case study in harnessing the best of two communities — research infrastructures as originally conceived of in the sciences, and the arts and humanities research base — and merging them in sometimes unexpected ways to create a different, but optimally focussed, proposed range of services. Digital research networks such as DARIAH, however, are also part of a transnational history of materialising Europe, which means that their importance extends beyond strictly scholarly work, opening up a range of central issues, such as:

1. What is the political capital of a digital infrastructure? What is the extent of its sovereignty? And how can we, the community of humanities researchers, make sure that the digital infrastructure — not even the one we are trying to build now, for ours are baby steps, but the future one, the one we hope to see built one day — does not turn from being a power grid into a grid of (hegemonic) power? Sheila Anderson already warned us in 2013 of the uncomfortable alliances research infrastructure development might cause us to make:

Although the primary aim of all these infrastructure programmes is to support research, the rhetoric in which they are framed by the funders tends to focus on the economic and political gains to be obtained rather than the advances in knowledge and understanding that they should help to bring about. This emphasis on newness, on innovation, on raising the profile of a country or a continent, conflicts on a number of levels with the reality of infrastructure and its perceived value.⁴⁴

As the ESFRI roadmap continues to grow, putting pressure on the countries involved in multiple ERICs, and the requirement comes into focus that infrastructures serve industry as well as research, we forget such warnings at our peril, lest we put research at the service of infrastructure rather than vice versa.

2. Infrastructures, in general, have a tendency to disappear out of sight: once the novelty of their implementation wears off, they tend to become invisible or self-evident, taken for granted except for when they fail, inscribed as ‘a kind of objective unconscious in our lives’.⁴⁵ As we build our digital infrastructures today, we need to prepare for their ‘disappearance’ tomorrow. We need to think about what type of inherent cultural values and what type of control mechanisms we are programming into digital infrastructures as public institutions before we accept them as an invisible substrate for our work.

⁴⁴ Sheila Anderson, ‘What are Research Infrastructures?’, *International Journal of Humanities and Arts Computing*, 7.1–2 (2013), 4–23 (p. 7).

⁴⁵ Dirk van Laak, ‘Infra-Strukturgeschichte’, *Geschichte und Gesellschaft*, 27.3 (2001), 367–93 (p. 367).

3. The logic of infrastructures is the logic of industrial society: it is based on normativity, mass production, serialisation, and, ultimately, social discipline.⁴⁶ As we build a digital infrastructure for the humanities, how do we make sure that we do not end up locking ourselves in, disciplining ourselves to the point that technical protocols become our only destiny, and the limits of our intellectual horizons?
4. When infrastructures remain visible, they usually do so by their absence: in places where they do not exist and where their lack is a very clear indicator of large-scale social inequalities and injustices. We should ask ourselves about the implications of digital infrastructure projects for the dynamics between those who are in and those who are out. Can we create a truly European infrastructure? When will be a good time to start thinking beyond Europe? What are the actual, physical limits of a scientific infrastructure?

DARIAH has come a long way in navigating the dangerous waters of research infrastructure development for the arts and humanities in the digital age. For all the (mistaken, but common) conceptualisations of infrastructure as a one-off capital expenditure, what seems most apparent is that it is a moving target in the digital age, shifting in its ideal focus and service profile as not only the researchers' needs change, but also the environment, the incentives, and the power relations change. As DARIAH moves through its second decade these may be its biggest challenges.

Appendix 9.A: Definitions of Research Infrastructure

[...] facilities, resources or services of a unique nature that have been identified by pan-European research communities to conduct top-level activities in all fields. This definition of Research Infrastructures, including the associated human resources, covers major equipment or sets of instruments, as well as knowledge-containing resources such

46 K. J. Beckmann, *Vom Umgang mit dem Alltäglichen. Aufgaben und Probleme der Infrastrukturplanung* (Karlsruhe: Institut für Städtebau und Landesplanung, Universität Karlsruhe, 1988); Mettler-Meibom, B. and C. Bauhardt (Hg.), *Nahe Ferne - fremde Nähe. Infrastrukturen und Alltag* (Berlin: Edition Sigma, 1998).

as collections, archives and databases. Research Infrastructures may be 'single-sited', 'distributed', or 'virtual' (the service being provided electronically). They often require structured information systems related to data management, enabling information and communication. These include technology-based infrastructures such as grid, computing, software and middleware.⁴⁷

Morphologically, digital infrastructures can be defined as shared, unbounded, heterogeneous, open, and evolving sociotechnical systems comprising an installed base of diverse information technology capabilities and their user, operations, and design communities.⁴⁸

In its widest sense, infrastructure allows us, as finite individuals, to achieve beyond our individual capacity to know, to do, to see.⁴⁹

Infrastructure gets

'below the level of the work', i.e. without specifying exactly how work is to be done or exactly how information is to be processed (Forster and King, 1995). Most systems that attempt to force conformity to a particular conception of a work process (e.g., Lotus Notes) have failed to achieve infrastructural status because they violate this principle. By contrast, email has become fully infrastructural because it can be used for virtually any work task.⁵⁰

[...] the term cyberinfrastructure is meant to denote the layer of information, expertise, standards, policies, tools, and services that are shared broadly across communities of inquiry but developed for specific scholarly purposes: cyberinfrastructure is something more specific than the network itself, but it is something more general than a tool or a resource developed for a particular project, a range of projects, or, even more broadly, for a particular discipline. So, for example, digital history collections and the collaborative environments in which to explore and analyze them from multiple disciplinary perspectives might be considered cyberinfrastructure, whereas fiber-optic cables and storage area networks or basic communication protocols would fall below the line for cyberinfrastructure.⁵¹

47 European Strategy Forum for Research Infrastructures, *European Roadmap*, p.16.

48 David Tilson, Kalle Lyytinen, and Carsten Sørensen, 'Research Commentary — Digital Infrastructures: The Missing IS Research Agenda', *Information Systems Research*, 21.4 (2010), 748–59, <https://doi.org/10.1287/isre.1100.0318>.

49 Jennifer Edmond, 'CENDARI's Grand Challenges: Building, Contextualising and Sustaining a New Knowledge Infrastructure', *International Journal of Humanities and Arts Computing*, 7.1–2 (2013), 58–69 (p. 58), <https://doi.org/10.3366/ijhac.2013.0081>

50 Paul N. Edwards et al., *Understanding Infrastructure*, p. 17.

51 American Council of Learned Societies, *Our Cultural Commonwealth*, p. 1.

Infrastructures mediate. They are the structures ‘in between’ that allow things people and signs to travel across space by means of more or less standardised paths and more or less standard protocols for conversation or translation. Thinking of infrastructures as mediating interfaces, that is as points of interaction and translation on material, institutional and discursive levels allows us to get to the heart of the dynamics we seek to capture.⁵²

Bibliography

- American Council of Learned Societies, *Our Cultural Commonwealth: The Report of the American Council of Learned Societies Commission on Cyberinfrastructure for the Humanities and Social Sciences* (New York: American Council of Learned Societies, 2006) https://www.acls.org/uploadedFiles/Publications/Programs/Our_Cultural_Commonwealth.pdf
- Anderson, Sheila, ‘What are Research Infrastructures?’, *International Journal of Humanities and Arts Computing*, 7.1–2 (2013), 4–23.
- Antonijević, Smiljana, *Amongst Digital Humanists: An Ethnographic Study of Digital Knowledge Production* (London: Palgrave Macmillan).
- Atkins, Daniel E., et al., *Revolutionizing Science and Engineering Through Cyberinfrastructure: Report of the National Science Foundation Blue-Ribbon Advisory Panel on Cyberinfrastructure* (Washington, DC: National Science Foundation, 2003), <https://www.nsf.gov/cise/sci/reports/atkins.pdf>
- Badenoch, Alexander, and Andreas Fickers, ‘Introduction Europe Materializing? Toward a Transnational History of European Infrastructures’, in *Materializing Europe: Transnational Infrastructures and the Project of Europe*, ed. by Alexander Badenoch and Andreas Fickers (London: Palgrave Macmillan, 2010), pp. 1–23, https://doi.org/10.1057/9780230292314_1
- Beckmann, K. J., *Vom Umgang mit dem Alltäglichen. Aufgaben und Probleme der Infrastrukturplanung* (Karlsruhe: Institut für Städtebau und Landesplanung, Universität Karlsruhe 1988).
- CLARIN ERIC, <https://www.clarin.eu/>
- DARIAH-EU, <https://www.dariah.eu/>
- Edmond, Jennifer, ‘CENDARI’s Grand Challenges: Building, Contextualising and Sustaining a New Knowledge Infrastructure’, *International Journal of Humanities and Arts Computing*, 7.1–2 (2013), 58–69, <https://doi.org/10.3366/ijhac.2013.0081>
- ‘Tradition and Innovation in the Cendari Research Infrastructure’, *Review of the National Center for Digitization 25*, ed. by Zoran Ognjanović (Belgrade: Faculty of Mathematics, University of Belgrade, 2015), pp. 2–9.

52 Badenoch and Fickers, ‘Introduction’, p. 2.

- Edwards, Paul N., et al., *Understanding Infrastructure: Dynamics, Tensions and Design* (Ann Arbor, MI: Deep Blue), <http://hdl.handle.net/2027.42/49353>
- EOSCpilot, <https://eosc-pilot.eu/>
- EOSC-hub, <https://eosc-hub.eu/>
- European Strategy Forum for Research Infrastructures, *European Roadmap for Research Infrastructures Report 2006* (Luxembourg: Office for Official Publications of the European Communities, 2006), https://ec.europa.eu/research/infrastructures/pdf/esfri/esfri_roadmap/roadmap_2006/esfri_roadmap_2006_en.pdf
- Fischer, Frank, 'Towards the DARIAH Marketplace. An Appstore for the Humanities', Keynote Address at DARIAH Innovation Forum, Aarhus, Denmark, November 2–4 2017.
- Foster+, <https://www.fosteropenscience.eu/>
- High Integration of Research Monographs in the European Open Science Infrastructure (HIRMEOS), <http://www.hirmeos.eu>
- Knowscape Project, *Memorandum of Understanding for the Implementation of a European Concerted Research Action Designated as COST Action TD1210: Analyzing the Dynamics of Information and Knowledge Landscapes — KNOWeSCAPE* (Brussels: COST European Cooperation in the Field of Scientific and Technical Research, 2012), <http://knowscape.org/wp-content/uploads/2013/04/TD1210-e.pdf>
- Liu, Alan, 'Toward Critical Infrastructure Studies', Paper Presented at the University of Connecticut, Storrs, 23 February 2017, <http://cistudies.org/wp-content/uploads/Toward-Critical-Infrastructure-Studies.pdf>
- Mettler-Meibom, B., and C. Bauhard, eds., *Nahe Ferne — fremde Nähe. Infrastrukturen und Alltag* (Berlin: Edition Sigma, 1998).
- Moedas, Carlos, 'The European Open Science Cloud — The New Republic of Letters', *European Commission* (12 June 2017), https://ec.europa.eu/commission/commissioners/2014-2019/moedas/announcements/eosc-summit-european-open-science-cloud-new-republic-letters_en
- Moulin, Claudine, et al., *Research Infrastructures in the Digital Humanities* (Strasbourg: European Science Foundation, 2011), http://www.esf.org/fileadmin/user_upload/esf/RI_DigitalHumanities_B42_2011.pdf
- Nowviskie, Bethany, ed., *#Alt-Academy 01: Alternative Academic Careers for Humanities Scholars* (New York: MediaCommons Press, 2014), <http://mediacommons.org/alt-ac/>
- OpenAIRE+, <https://www.openaire.eu/>
- Open Scholarly Communication in the European Research Area for Social Sciences and Humanities (OPERAS), <https://operas.hypotheses.org/>

- 'Open Science Policy Platform', *European Commission*, <https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-policy-platform>
- Open Science MOOC, <https://opensciencemooc.eu/>
- Raley, Rita, 'eEmpires', *Cultural Critique*, 57 (2004), 111–50, <https://doi.org/10.1353/cul.2004.0014>
- Rockwell, Geoffrey, and Stéfan Sinclair, 'Acculturation and the Digital Humanities Community', in *Digital Humanities Pedagogy: Practices, Principles and Politics*, ed. by Brett D. Hirsch (Cambridge: Open Book Publishers, 2012), pp. 177–211, <https://doi.org/10.11647/obp.0024.08>
- Romer, Paul, 'Economic Growth', *Library of Economics and Liberty*, <http://www.econlib.org/library/Enc/EconomicGrowth.html>
- Schmunk, Stefan, et al., 'Interoperabel und partizipativ' in *Digitale Infrastrukturen für die germanistische Forschung*, ed. by Henning Lobin, Roman Schneider, and Andreas Witt (Berlin: De Gruyter, 2018), pp. 53–72, <https://doi.org/10.1515/9783110538663-004>
- SSHOC, <https://sshopencloud.eu/>
- Svensson, Patrik, 'From Optical Fiber to Conceptual Cyberinfrastructure', *Digital Humanities Quarterly*, 5.1 (2011), <http://www.digitalhumanities.org/dhq/vol/5/1/000090/000090.html>
- Szoniecky, Samuel, 'Ecosystems of Collective Intelligence in the Service of Digital Archives', in *Collective Intelligence and Digital Archives: Toward Knowledge Ecosystems*, ed. by Samuel Szoniecky and Nasreddine Bouhaï (Hoboken, NJ: Wiley, 2017), pp. 1–22, <https://doi.org/10.1002/9781119384694.ch1>
- Tilson, David, Kalle Lyytinen, and Carsten Sørensen, 'Research Commentary — Digital Infrastructures: The Missing IS Research Agenda', *Information Systems Research*, 21.4 (2010), 748–59, <https://doi.org/10.1287/isre.1100.0318>.
- UC Digital Humanities, 'Dr. Tim Sherratt: Towards a Manifesto for Tactical DH Research Infrastructure', *Youtube*, 2 November 2015, <https://www.youtube.com/watch?v=FL5pP2ysjU4>
- Van Laak, Dirk, 'Infra-Strukturgeschichte', *Geschichte und Gesellschaft*, 27.3 (2001), 367–93.
- Williams Woolley, Anita, Ishani Aggarwal, and Thomas W. Malone, 'Collective Intelligence in Teams and Organisations', in *Handbook of Collective Intelligence*, ed. by Thomas W. Malone and Michael Bernstein (Cambridge, MA: MIT Press, 2015), pp. 143–57.
- Williamson, Oliver E., 'The Economics of Organization: The Transaction Cost Approach', *American Journal of Sociology*, 87.3 (1981), 548–77.